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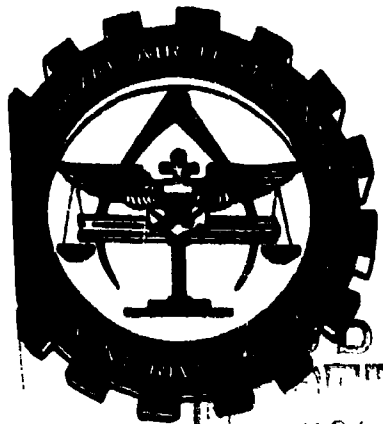
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REPORT NO. ST35438R-63
TASK NO. RAE20P031
PROBLEM NO: 031-AE22-33
DATE 1 Aug 1963



NOV 27 1963

NAVAL AIR TEST CENTER TECHNICAL REPORT

THIRD INTERIM REPORT

(6) TEST FLIGHT OF PILOTS' FLASHBLINDNESS
HELMETS, GOGGLES, GLASSES, AND ASSOCIATED SYSTEMS.

by
LCDR E. P. Jacobs, MC, USN

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NAVAL AIR TEST CENTER
U. S. NAVAL AIR STATION
PATUXENT RIVER, MARYLAND

RAE20P031
031-AE22-33
ST35-38R-63

1 Aug 1963

From: Commander, Naval Air Test Center
To: Chief, Bureau of Naval Weapons

Subj: NATC Technical Report ST35-38R-63, Test Flight of
Pilots' Flashblindness Helmets, Goggles, Glasses,
and Associated Systems, Third Interim Report (U);
transmittal of

Ref: (a) WEPTASK Assignment Number RAE20P031/2011/F012
10 02 of 18 Jun 1962
(b) Problem Assignment Number 031-AE22-33 of
21 Feb 1963
(c) NATC rept 031-AE22-33 ST35-8R-63 of 15 Jul 1963
(d) NATC rept 031-AE22-33 ST35-9R-63 of 9 Jul 1963

1. Reference (a) authorized the flight test and service
evaluation of physiological protective devices. Reference
(b) requested laboratory and flight tests of pilots' flash-
blindness helmets, goggles, glasses, and associated systems.

2. References (c) and (d) are the first and second interim
reports on the evaluation.

PAUL H. RAMSEY

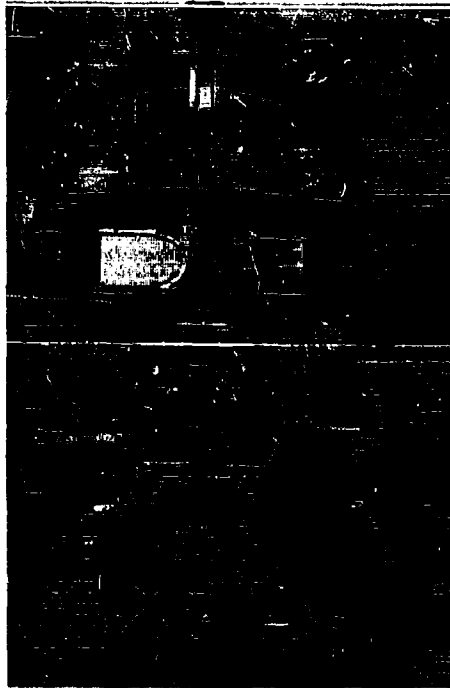
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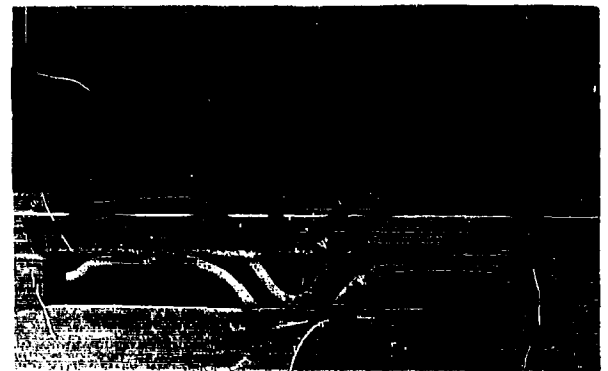
Test Flight of Pilots' Flashblindness Helmets,
Goggles, Glasses, and Associated Systems
Third Interim Report (U)

by

LCDR E. P. JACOBS, MC, USN



Electromechanical Goggles



Light Leakage Kit

ABSTRACT

✓ The light leakage kit (FAB 2806-APH-6 Helmet) was evaluated as a light-seal between the APH-5/6 helmet visor and A13-A oxygen mask. The light leakage kit is not suitable for service use because it was not compatible with the A13-A oxygen mask, and could not be modified to provide an adequate light-seal. ~~The National Cash Register Company~~ Electromechanical goggles were laboratory and flight tested to determine comfort, wearability, and effect on the pilot's ability to perform his mission. These goggles are not suitable for service use because they restrict visual fields, interfere with legibility of instruments, are uncomfortable, fog, and do not provide an adequate light-seal. ↗

INTRODUCTION

BACKGROUND

1. This problem assignment was established to provide for flight evaluation of pilots' flashblindness helmets, goggles, glasses, and associated systems. Tests were conducted from April to July 1963.

PURPOSE

2. This report contains results of the laboratory and flight tests of two items designed to protect pilots against flashblindness: a Light Leakage Kit (FAB 2806 - APH-6 Helmet), installed on APH-5/6 helmets equipped with gold coated visors, and the National Cash Register Company (NCR) Electromechanical goggles (EMG).

DESCRIPTION OF EQUIPMENT

LIGHT LEAKAGE KIT

3. The Light Leakage Kit (figure 1) consists of six pieces of pressure sensitive hook tape, precut for installation on the helmet visor, and a light-seal fabricated in the form of a black pile skirt faced with a thin layer of dark gray polyurethane foam. This skirt was designed to mate with the pressure sensitive hook tape on the visor and form a light-seal in the area between the visor and the A13-A oxygen mask.



Figure 1
Light Leakage Kit

ELECTROMECHANICAL GOGGLES

4. The NCR EMG assembly (figure 2) consists of a set of goggles connected by a shielded cable to a transistorized power pack. The power pack was designed to be attached to the pilot's flight clothing by a spring steel clip. Each goggle lens consists of vertical, silver plated metal shutters, mounted in a frame between two layers of glass. The lens frames are mounted in a thick sponge rubber light-seal. A ballistic motor unit is mounted on the goggle frame slightly above the bridge of the nose, with a mechanical linkage between the shutters and the motor unit. A vent is located directly behind the motor unit. A light sensing cell is located above each goggle lens. When triggered, this cell completes an electrical circuit between the power pack and the motor unit, firing a charge which propels a metal cylinder against a plunger (figure 3) mechanically closing the metal shutters. The shutters can be opened by removing the motor unit, or by rotating the motor unit until an unfired charge is aligned with the plunger. These procedures can be accomplished by releasing the spring

loaded locking lever below the right side of the motor unit. The motor unit contains a total of four charges. The goggles alone weigh 8 oz. The motor unit weighs 1 1/2 oz.

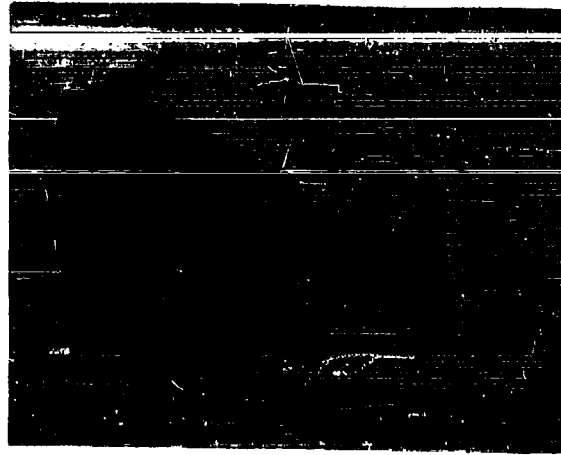


Figure 2
Electromechanical Goggles

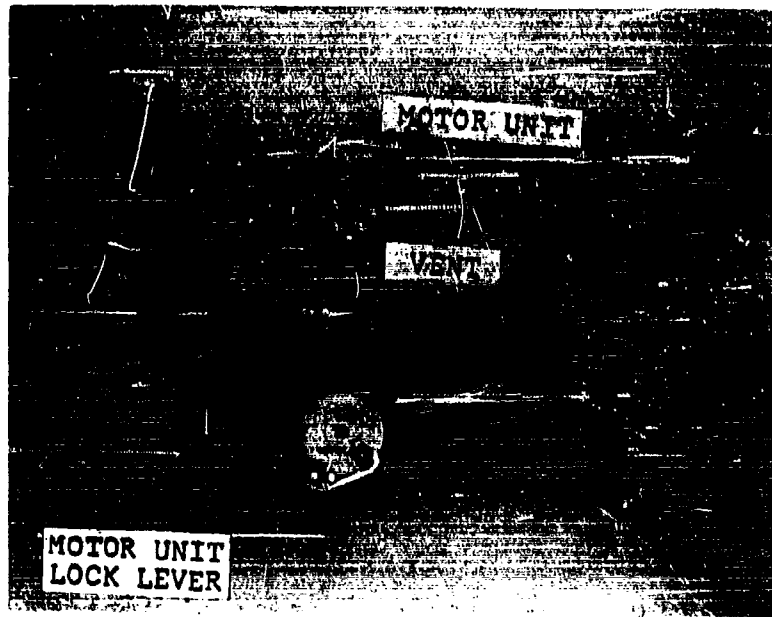


Figure 3
EMG Motor Unit Detail

SCOPE OF TESTS

5. The light leakage kit was evaluated with APH-5/6 helmet visors and Al3-A oxygen masks for compatibility, ease of installation, and efficiency as a light-seal. The EMG were subjected to laboratory, cockpit, and flight tests to determine compatibility with existing equipment, comfort, and effect on the pilot's ability to fly his airplane successfully.

METHOD OF TESTS

LIGHT LEAKAGE KIT

6. Each visor used in these tests was trimmed and fitted to the pilot's Al3-A oxygen mask to achieve maximal light-seal prior to installation of the light leakage kit. The precut strips of hook tape were cemented to the visor and the skirt was trimmed and installed in accordance with the kit instructions (Appendix I).

7. The effectiveness of each light leakage kit was reported after laboratory and flight tests by the pilot to whom it had been fitted.

ELECTROMECHANICAL GOGGLES

LABORATORY TESTS

8. Subjects were tested in an Aviation Medicine Eye Examining room to determine the effects of the EMG on visual acuity, depth perception, and phorias.

9. A comparison was made of the measurements of the visual fields of the subject wearing APH-5/6 helmets with and without the EMG.

10. Tests were conducted to determine the efficiency of the EMG to preserve dark adaptation after actuation.

COCKPIT TESTS

11. Subjects wore the EMG with various types of service, prototype and experimental helmets in the cockpits of various aircraft to determine the adequacy of visual fields with respect to instruments, consoles and controls, and the external environment while the subject was seated in normal flight position.

ST35-38R-63

FLIGHT TESTS

12. The EMG were tested during day, night, and twilight flights under VFR and IFR conditions. The subjects submitted flight reports on the comfort of the EMG and on its compatibility with personal equipment and the cockpit. Special attention was given before and after actuation, and during change of motor units, to visual problems, and to effects of the EMG on the pilot's ability to fly the airplane.

RESULTS AND DISCUSSION

LABORATORY TESTS AND FITTING

LIGHT LEAKAGE KIT

13. The light leakage kit could not be fitted to the APH-5/6 visor to provide an adequate light-seal with the A13-A oxygen mask (figure 4).

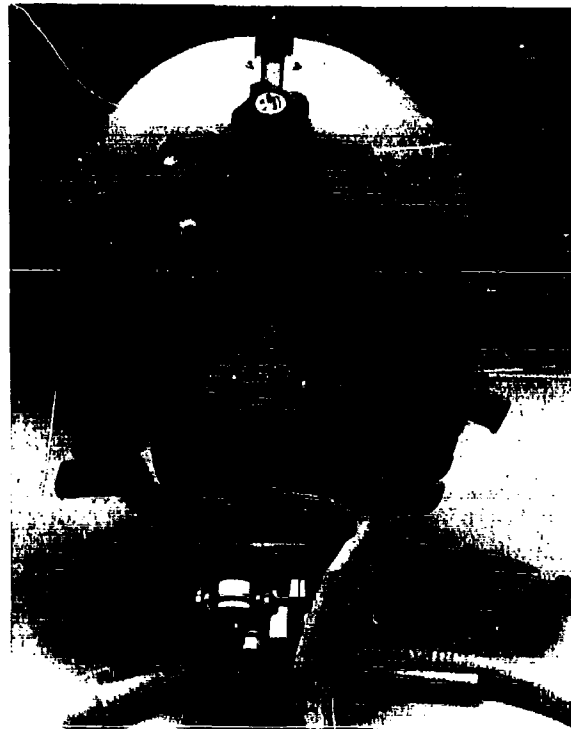


Figure 4
Light Leakage Kit

14. Local modifications of the skirt and hook tape contained in the light leakage kit to form an adequate light-seal were unsuccessful. The kit is unsuitable for service use in that it failed to provide an adequate light-seal.

ELECTROMECHANICAL GOGGLES

15. No degradation of visual acuity attributed to the EMG was detected by the Snellen Chart method. A Bausch & Lomb phorometer was used to test aviation personnel, with and without the EMG, for phorias, and for prism divergence at 20 ft and at 13 in. A summary of the results of these tests is shown in Table I.

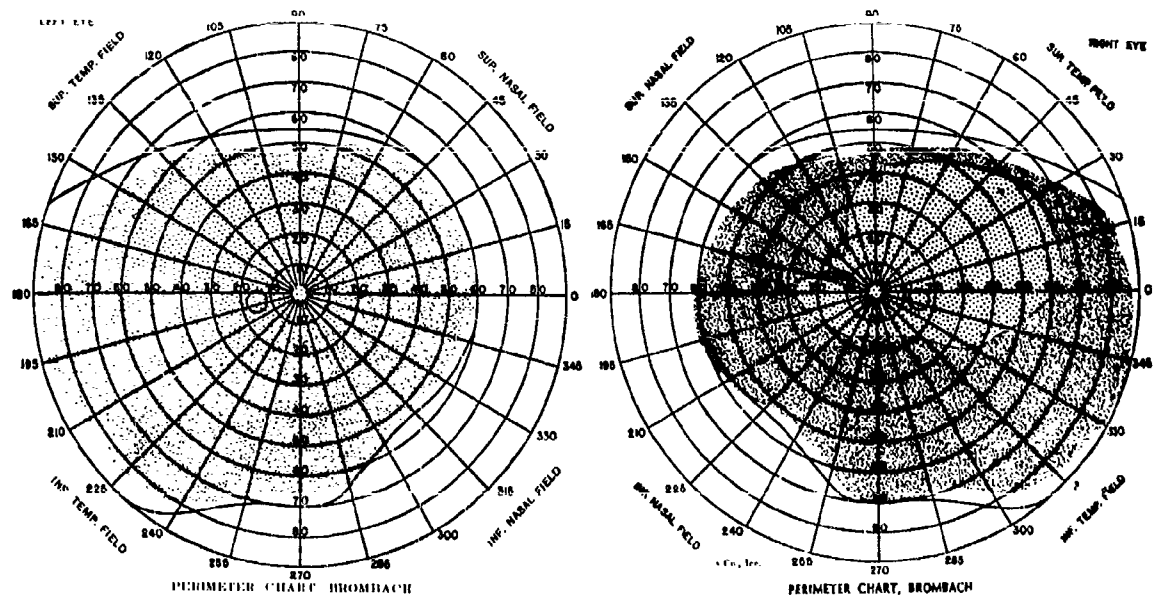
Table I

Results of Phorometer Tests on Aviation Personnel

<u>Without EMG</u>	<u>With EMG</u>
Orthophoria	Some degree esophoria
Esophoria	Increased up to 3 times
Exophoria	Decreased; some became esophorias
Hyperphoria	Slight increase
Prism Divergence at 20 ft	Slight increase
Prism Divergence at 13 in.	Slight increase

The Verhoff method was used to determine depth perception with and without the EMG. Ninety percent of the personnel who had passed the Verhoff test with uncorrected vision failed the Verhoff test when wearing the EMG. Interference with depth perception is unacceptable.

16. Perimeter tests revealed a marked reduction of peripheral vision with the EMG, as indicated in the composite perimeter charts (figure 5). The over-all reduction of the nasal fields and the asymmetrical reduction of the right superior nasal field was consistent for all subjects. These reductions of nasal fields were caused by the 1 in. separation between the goggle lenses across the bridge of the nose and by the motor release lever over part of the right lens. Repeated perimeter tests on any given subject showed minor jagged deviations in outline in the temporal fields, caused by shutter interference. The variations in superior and inferior fields were probably caused by the shutters in the lenses. Other quadrants of reduced vision varied with subjects. The differences of facial anatomy, particularly the nasal contours, accounted for the variation between subjects. Flight tests of the goggles were restricted to dual control aircraft because of the severe reduction of peripheral vision. The EMG are unacceptable because of the reduction they create in the wearer's field of vision.





-  APU-6 Helmet and A13-A Oxygen Mask with Clear Visor
-  APU-6 Helmet and A13-A Oxygen Mask with EMG

Figure 5
Composite Perimeter Chart

17. The EMG admitted unacceptable amounts of light when tested with four 500 W photoflood lights located in pairs two feet laterally and ten degrees behind each side of the subject's head.

COCKPIT STUDIES

18. Evaluations of instrument, console, and control visibility conducted in the cockpits of various aircraft verified the laboratory EMG perimeter studies. All tests were conducted with the seat adjusted so as to align the subject's optic axes with the design eye plane. The reduction of visual fields by the EMG caused most subjects to assume a head down position to see the essential flight instruments. This position was both uncomfortable and unsafe.

19. Pilots reported that the goggle shutters obscured the view of numbers on small instruments and at times obscured instrument needles which were in a vertical position. Younger pilots with a wide range of accommodation had more trouble with shutter interference than older pilots whose near point of near vision was beyond the lens shutters. Any obstruction to the pilot's view of his instruments is unacceptable.

FLIGHT TESTS

20. The EMG limited the pilot's peripheral vision to the extent that it was inadequate for safe solo flight. The reduction of the inferior visual fields required the pilots to fly with their necks flexed (head bent forward), resulting in discomfort, fatigue, and further reduction in lateral visual fields. The relationship of the EMG glass area to the pilot's optic axes could not be adjusted and no improvement of peripheral vision could be achieved.

21. Although the EMG were not excessively heavy they caused discomfort, due to pressure points around the face seal. They were uncomfortably hot and caused excessive perspiration under the goggle face seal. The vent was inadequate and the goggles fogged on hot days or when the flight course was toward the sun. Goggles must be provided with adequate ventilation to prevent fogging.

22. In addition to the problems noted during ground cockpit evaluations, the EMG shutters caused double light, instrument number, and needle images during night flights. Console lights had to be turned up to full bright to enable the pilot wearing the EMG to see console controls and instruments. Any distortion of vision by an optical system designed for pilot use is unacceptable.

COMPATIBILITY WITH PERSONAL EQUIPMENT

23. The EMG were capable of being modified for use with all service and experimental helmets except full and partial pressure suit helmets and experimental helmets which enclose the entire head.

24. The EMG power pack was capable of being attached to all standard summer and winter aviation clothing without any special container. The cable from the EMG to power pack had to be routed under the parachute riser and shoulder restraint straps, when the battery was located on the lateral torso or arm, to prevent loss of goggles during parachute deployment.

DURABILITY

25. The only failure that occurred during the test period was of the motor release lever spring. The tension of this spring decreased with use and allowed it to separate from the mechanism each time the motor unit was removed or rotated. The failure prevented adequate in-flight evaluation of the pilot's ability to rotate or change the motor unit after actuation. The motor unit release lever spring should be durable and adequately secured.

GENERAL

26. Black sponge rubber was used for the EMG light seal, and a black finish used on the motor unit, portions of the frame, and the cable from the EMG to the battery. The entire outer surface and all accessories to the EMG should be white or have a highly reflective surface to reduce absorption of thermal energy.

CONCLUSIONS

SERVICE SUITABILITY

LIGHT LEAKAGE KIT

27. The light leakage kit does not provide a satisfactory light-seal with the A13-A oxygen mask (paragraphs 13 and 14).

ELECTROMECHANICAL GOGGLES

28. The EMG is not suitable for service use for the following reasons:

- a. Interference with depth perception (paragraph 15).
- b. Excessive reduction of peripheral vision (paragraphs 16 and 18).
- c. Incomplete closure of the shutters after actuation (paragraph 17).
- d. Interference with legibility of instruments (paragraphs 19 and 20).
- e. Discomfort (paragraph 21).
- f. Poor ventilation and fogging (paragraph 21).
- g. Poor attachment and durability of the motor unit release lever spring (paragraph 25).
- h. Use of black finish (paragraph 26).

RECOMMENDATIONS

29. The light leakage kit (FAB 2806-APH-6 Helmet) should not be accepted for service use with the Al3-A oxygen mask.
30. The EMG should not be accepted for service use.

REFERENCES

1. Light Leakage Kit - FAB 2806-APH-6 Helmet, Instruction Sheet

APPENDIX I

Naval Air Test Center, Patuxent River, Md.
TEST FLIGHT OF PILOTS' FLASHBLINDNESS HELMETS,
GOGGLES, GLASSES, AND ASSOCIATED SYSTEMS, THIRD
INTERIM REPORT (U), LCDR E. P. Jacobs, MC, USN,
1 August 1963, 13 p., photo., 1 App.
(NATC TECHNICAL REPORT ST35-38R-63)

The light leakage kit (FAB 2806-APH-6 Helmet) was evaluated as a light-seal between the APH-5/6 helmet visor and Al3-A oxygen mask. The light leakage kit is not suitable for service use because it was not compatible with the A-13A

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